and from Pasteur, Cohn, and others we know of diseases due to those simplest of fungi, the Bacteria, which produce the most deadly ravages amongst insects. Prof. Metschnikoff has examined some of these minute parasitic fungi and cultivated them by passing them from one insect to another, and has experimentally proved their very deadly character to the insects exposed to infection. The "green Muscardine" (*Isaria destructor*) is the name given by Metschnikoff to one of the minute fungi the effects of which he most successfully traced. Now it is perfectly evident that if green Muscardine spores could be produced in large quantity, or spores of similar disease-producing fungi, and applied to the ground and shrubs infested by insect-pests liable to harbour those fungi, we should have the best of all means for effecting the destruction of the insects, viz., a poison which once set at work would spontaneously multiply and spread its destroying agents around.

Accordingly Prof. Metschnikoff endeavoured to cultivate the "green Muscardine" apart from insects, so as to obtain its spores if possible in great quantity, in a liquid which might be applied to places attacked by injurious insects. He at last succeeded in effecting this cultivation by the use of beer-mash in this decoction the green Muscardine produced a rich mycelium and finally spores.

It is exceedingly probable that we have here the true explanation of the value of the application of yeast to plants, &c., affected by insect pests. If there are a few spores only of such parasites as the "green Muscardine" about, the fluids of the yeast will serve them for nourishment and so cause the Muscardine to spread until it comes into contact with the insects. There is no reason to suppose that the beer-yeast plant itself is capable of generating a disease in any insects, at the same time we must remember that yeast as ordinarily used by the brewer is by no means pure; it contains in small quantities other minute fungi besides the *Saccharomyces cerevisiæ*, and it is quite possible that a given quantity of it, say a pint, *may*, if the brewery from which it came were not conducted on the most perfect system (such as that lately introduced by Pasteur), contain a few spores of such a disease-producing parasite as Muscardine. A diseased insect once in a way falling into the mash-tub would sufficiently keep up the supply, and thus it is possible that yeast may carry infection to insect-pests and destroy them.

At the same time Prof. Metschnikoff's suggestion of a deliberate cultivation of an insect's-disease-producing fungus, and the application of the cultivated fungus in quantity to places infested by these insects, is in the highest degree ingenious and likely to give results the value of which will be estimated in thousands of pounds, and so do something to persuade "practical" men that all science is deserving of their respect and encouragement.

E. RAY LANKESTER

THE CLASSIFICATION OF THE ENGLISH TERTIARIES

AT the last meeting of the Geological Society of London an animated discussion took place upon the question of the true correlation of the strata of the Hampshire Basin with those of France, the Netherlands, North Germany, Switzerland, and other parts of Europe. This discussion was raised by a memoir read by Prof. Judd, who showed that the accepted order of succession in the series of fluvio-marine strata of the Isle of Wight is not the true one, but that the formation in question is of much greater thickness and importance than had hitherto been supposed by geologists.

These fluvio-marine strata of the Hampshire Basin, which, as is well known, are quite unrepresented in the London area, have attracted much attention from British and foreign geologists. The order of their succession has been the subject of frequent controversies in the past, for, like all deposits formed in deltas, the beds are inconstant in character and thickness, and it is difficult to trace them at the surface by the art of the geological surveyor; furthermore, the districts of the New Forest and the northern half of the Isle of Wight, in which the strata in question are found, are covered with thick deposits of sand and gravel, so that the underlying strata are seldom exposed except in sea cliffs and in such artificial openings as railway-cuttings, brickyards, quarries, and wells.

The first classification which was proposed for these beds was the result of the long and careful study of the geology of the Isle of Wight by Thomas Webster. He believed that the fluvio-marine beds consist of a set of marine strata with fresh-water deposits above and below them. But the more careful study of the palæontology of the formation by Prestwich and Edward Forbes proved that Webster had confounded in his "marine series" several strata which are on very distinct geological horizons. In the memoir now laid before the Geological Society Prof. Judd carries the question one step further in the same direction, and demonstrates that strata exposed at Colwell Bay and at the base of Headon Hill are not, as was hitherto supposed, upon the same horizon, but that the latter underlie the former. The classification now proposed for these fluvio-marine strata, which are shown to have a thickness of from 800 to 900 feet, is as follows:—

Hempstead series (marine and estuarine) ...	100 feet.
Bembridge group (freshwater and estuarine)	300 ,,
Brockenhurst series (marine)	25 to 100 ,,
Headon group (freshwater and estuarine), including the Headon Hill sands	400 ,,

The Headon group is proved to be the exact representative of the *Zone of Cerithium concavum* which has been recognised at so many points upon the Continent.

Edward Forbes's division of the "Osborne and St. Helen's Series" it is shown must be abandoned, on the ground that it presents no good features, either mineralogical or palæontological, by which it can be distinguished, and its separation was founded on an error in working out the true order of succession of the beds. On the other hand, the marine strata seen about Lyndhurst and Brockenhurst in the New Forest, and at Colwell Bay and Whitecliff Bay in the Isle of Wight, are shown to constitute a division of very great importance for which the name of the *Brockenhurst Series* is proposed.

Since the date of Edward Forbes's study of these beds, much new light has been thrown upon their age and relations by the collection and study of the fossils which they contain; the number of species now known to us is probably, at least four times as great as those with which Forbes was acquainted, this result being mainly due to the labours of the late Mr. Frederick Edwards and other indefatigable collectors of tertiary fossils.

It is greatly to be desired that the rich stores of molluscan, reptilian, and mammalian fossils, which exist in the British and other museums, should be described by competent naturalists, as much new light would thereby be thrown on the life of the period when these beds were deposited.

Great difficulty has always been experienced by English geologists in referring the fluvio-marine beds of the Isle of Wight and the New Forest to their proper place among the great divisions of the Tertiary strata. Some authors place the whole of these beds in the Eocene, but this can only be done by unnaturally extending upwards the bounds of that division so as to include these Isle of Wight strata. In the paper just read to the Society, Prof. Judd shows that while the several marine Eocene faunas, those namely of the Barton, the Bracklesham, and the Bognor beds, are very closely related to one another, the Brockenhurst fauna has but little in common with them. Thus, out of nearly 200 species of marine shells found in

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the Brockenhurst series, not more than one-fifth occur in the Barton clay (Upper Eocene) below. The Hempstead marine fauna has still fewer species in common with the Eocene.

The late Sir Charles Lyell proposed to divide the fluvio-marine series into two portions, and to group one with the Eocene and the other with the Miocene. But the inconvenience of breaking up this homogeneous series of beds into two portions must be apparent to every one.

Under these circumstances it is felt by geologists that the fluvio-marine strata of the Hampshire basin must be referred to a division of the Tertiaries distinct alike from the Eocene and the Miocene, and this was admitted by almost every one who took part in the discussion last Wednesday, including Prof. Prestwich and Dr. Duncan.

In the year 1854, Prof. Beyrich, of Berlin, showed that under the great masses of gravels and drift that cover such large tracts in North Germany, and immediately overlying the great Brown-coal formation of the country, there exist marine beds which contain a fauna distinct alike from the fauna of the Miocene and from that of the Eocene; and strata containing the same fauna have since been discovered in the Netherlands, Switzerland, and other parts of Europe. For the division of the tertiary series which contains this fauna, Beyrich proposed the name of the *Oligocene*. Whether or not its author was happy in the choice of this name, no one can doubt that he has sufficiently demonstrated the distinct character of the great system of beds to which he applies it.

In 1867 von Koenen and Duncan, from a study of the molluscan and coral fauna of the Brockenhurst beds, respectively, proved that the fluvio-marine strata of the Hampshire basin represents the North German Oligocene; and the justice of this correlation is placed beyond doubt in the memoir by Prof. Judd which has just been rend. He shows that the Headon group and the Brockenhurst series represent the lower Oligocene, while the Bembridge group and the Hempstead series are the equivalents of the lower part of the middle Oligocene, the upper Oligocene not being represented in this country.

That the Oligocene is a very important division of the geological series is shown by the fact that in Eastern Europe (Hungary and Transylvania) strata of this age attain a thickness of between 2,000 and 3,000 feet, and contain valuable beds of coal, while in the neighbourhood of the Alps they are from 10,000 to 12,000 feet thick. It is interesting to find that the lower portion at least of this great formation is represented in our own country, and by strata of such thickness and importance.

A NEW CLASS OF RHIZOPODA

AT a meeting of the Natural History Society of Jena the following note was read by Prof. Ernst Haeckel: "Upon the PHÆODARIA, a new Group of Marine Siliceous Rhizopods."

The Phæodaria are a group of large marine Rhizopods, rich in specific forms and remarkable in many respects, which have hitherto been included in the typical Radiolaria (Sphæridea, Discidea, Cyrtidea, Cricoidea), from which they differ as widely as do the Acanthometrina. Till lately very few forms of the Phæodaria were known; these were first observed by me at Messina in 1859, and described in my monograph of the Radiolaria in 1862, as representatives of three different families—

1. Aulacanthidæ (genus *Aulacantha*).
2. Aulosphæridæ (genus *Aulosphæra*).
3. Cœlodendridæ (genus *Cœlodendrum*).

Besides these, I had described two other forms belonging to this group, namely, *Thalassoplancta*, which I placed among the Thalassosphæridæ, and *Dictyocha*, which I placed among the Acanthodesmidæ.

Quite a new light has been thrown upon these interesting Rhizopods by the *Challenger* expedition, which discovered so many forms of the typical Radiolaria in the depths of the Pacific Ocean, that I have been able to define more than 2,000 new species. Besides these, the explorations of the *Challenger* have brought to light a number of deep-sea Phæodaria hitherto entirely unknown. The number of species of this group in the surface preparations in the *Challenger* collection which have been examined by me is not so considerable.

John Murray gave, in 1876, a short account of some of the most peculiar forms of these new deep-sea Phæodaria, under the name of Challengeridæ (*Proceedings* of the Royal Society, 1876, vol. xxiv. pp. 471, 535, 536, Pl. 24, Figs. 1–6). He draws particular attention, on the one hand, to the extremely delicate and finely-fenestrated structure of the large siliceous shells, and on the other hand to the constant appearance of masses of black-brown pigment which are scattered through the sarcode, outside the central capsule.

In the new arrangement of the Radiolaria given by me in 1878, in my article on the "Protista" (*Kosmos*, vol. iii.), I placed the hollow-spined siliceous Phæodaria already mentioned in a special order of Radiolaria, under the name of "Pansolenia": "The skeleton consists of single hollow tubes, loosely scattered, or connected in radial or concentric order" ("Protistenreich," p. 102).

This group was described in 1879 by Richard Hertwig, in his work on "The Organisation of the Radiolaria," as a special order of the class under the name of "Tripyleæ," with the following characters:—"Radiolaria Monozoa, with single nuclei; capsule-membrane double, with one principal and two lateral openings; skeleton siliceous, formed of tubes" (*l.c.*, p. 133, p. 87).

Neither the name "Tripyleæ," given by Hertwig, nor my name "Pansolenia" is applicable to all the Rhizopods which I have now placed in the group Phæodaria, as only a portion of these have the three openings in the double membrane of the central capsule, which ought to characterise the "*Tripyleæ*," and in a portion of them only the siliceous skeleton is formed of "hollow tubes" ("*Pansoleniæ*"). On the other hand, as Murray first showed, a striking character of all these Rhizopods is the constant presence of large dark-brown pigmented granules, scattered irregularly round the central-capsule, and covering the greater part of its outer surface. In brevity I call this extra-capsular mass of dark pigment the Phæodium (*φαιός* or *φαιοίδης* = dark brown, dusky). The Phæodella, or large brown granules of the Phæodium are not, as Murray supposed (*l.c.*, p. 536) true pigment cells, as a true cell nucleus cannot be observed in them; and the nature of the peculiar pigment of these pseudo-cells is not precisely known; but the quantity and constancy with which the Phæodium appears in all Phæodaria, while it is wanting in all the typical Radiolaria, gives the Phæodaria a high degree of systematic importance. It seems to me at present that the constant presence of the Phæodium and the peculiarly constructed membrane of the central-capsule are the only systematically reliable characters which separate all Phæodaria from all other Radiolaria.

The size of the Phæodaria is usually very striking in comparison with that of the other Radiolaria, which they greatly surpass in diameter. The greater number of the Phæodaria are visible to the naked eye, and many are from ½ 1 mm. or more in diameter. The conspicuous central capsule is usually round or spheroidal; it is, however, often egg-shaped or somewhat oval. In many cases it is monaxial, in others dipleuric. Its membrane is very firm and always double, the outer layer very thick, the inner thin. The opening through which the pseudopodia appear has the very peculiar structure accurately described by R. Hertwig (1878, *l.c.*). Many Phæodaria have only one such opening (*Monopyleæ*), others have two at the opposite poles of the central capsule (*Amphipyleæ*); many, perhaps the greater number, have three, one larger

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